Section of Epidemiology and State Medicine

President—H. J. PARISH, M.D.

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DISCUSSION: MODERN METHODS IN THE CONTROL OF AIRBORNE INFECTIONS [*Abridged*]

Dr. R. Cruickshank: Airborne infection may be defined as infection by inhalation and includes many of the specific fevers besides respiratory infections proper. The present incidence of airborne infection is high. Although the *mortality* due to measles and whooping-cough has fallen steadily during the last fifty years their *prevalence* is probably as great as it was a century ago. It is likely also that there has been no diminution in the incidence of the less well-defined "acute respiratory diseases" such as colds, febrile catarrh and influenza and their secondary complications. In America members of widely different social and geographical groups have been found to have on an average three colds a year. In Great Britain several investigations have shown that 40 to 50% of the time lost from work or school is due to acute respiratory infections including influenza (Smith, 1934, two communities in Glasgow; Report, 1938, children in boarding schools; Report, 1946*a*, adults in wartime). These infections are therefore a source of great economic loss.

Community foci from which respiratory diseases may be introduced into the family are the school; the day nursery (Report, 1946*b*); the train, tube or bus; the office or factory; and the cinema or other place of entertainment. The risk of infection in such places can be estimated by bacteriological sampling of the air using *Strep. viridans* as an index of pollution (Buchbinder *et al.*, 1938). The detection of tracer substances volatilized in the air (Lidwell and Lovelock, 1946) allows frequent measurements of ventilation rates. There is need for correlation of these methods with careful sickness records among workers in a factory or large institution.

The relative importance of droplets, dust and droplet nuclei in the spread of infection is best assessed by eliminating one variable and noting the effect on the cross-infection rate. Spread by direct droplets is contact rather than airborne infection. It is perhaps not very important in streptococcal infections because throat carriers of hæmolytic streptococci do not expel many organisms when they cough or talk (Hare and Mackenzie, 1946). However, the classical experiments of Dr. Alison Glover on the control of epidemic cerebrospinal fever showed the value of reducing the risk of droplet spread by increasing the space between adjacent beds. Similar measures reduced by 50% the epidemic incidence of acute respiratory disease in new recruits in the American Army (Commission on Acute Respiratory Disease, 1946*a*).

Infected dust was shown to be important when the incidence of streptococcal cross-infection rate. Spread by direct droplets is contact rather than airborne dust control developed in England by van den Ende and his colleagues. Nasal carriers of hæmolytic streptococci appear to be the most important contributors to infection of the environment (Hamburger *et al.*, 1945, 1946). On the other hand dust-control measures did not prevent the epidemic spread of acute respiratory disease among troops in training (Commission on Acute Respiratory Diseases,

1946*b*). Therefore spread by dust may be more important in bacterial than in virus infections.

Droplet nuclei are probably the usual mode of spread of virus infections where the infecting dose is small. Control of droplet nuclei by ultraviolet light has been achieved in America in the case of measles in school classrooms (Wells, Wells and Wilder, 1942) and of respiratory infections in infants at the Cradle Hospital.

The application of new methods of attack on the channels of airborne infection is enlightening the darkness that envelops this complex problem and we may take pride in the knowledge that many of the advances have originated from work done in this country.

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Dr. Joyce Wright discussed two trials of dust-control measures in measles wards. In the first trial (Wright *et al.*, 1944) oiling of blankets, bed linen, garments and floors in one ward reduced the bacterial and hæmolytic streptococcal counts of the air during bed-making to 91% and 98% respectively below those in a control ward. The streptococcal cross-infection rate was lower in the oiled ward than in the control (18·6 *versus* 73·3%) as was the rate of otorrhœa due to streptococcal cross-infection (2·8 *v.* 14·3%). Most cross-infections were due to type 6 streptococci. In the second trial (Begg *et al.*, 1947) bacterial counts in the control ward were low and there was less difference between them and counts in the oiled ward. The streptococcal cross-infection rate was higher in the oiled ward than in the control ward (20·5 *v.* 12·4%). The cross-infections were due to different types of streptococci and probably to contact spread. More cases with skin sepsis and streptococcal otorrhœa were admitted to the oiled than to the control ward despite alternate allocation of new patients. Dust-suppressive measures may be useful in measles wards if there is a high incidence of streptococcal infection.

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Mr. F. Courtney Harwood emphasized that good laundering methods are essential if oiling of fabrics is to be satisfactory. Oiling is a simple process if goods are washed and rinsed and softened water is used. Blankets can be steam sterilized without loss of oil. He said that research into laundering methods was continuing.

Dr. O. M. Lidwell discussed the results of laboratory tests of α-hydroxy-carboxylic acids as aerial disinfectants. Details will be published elsewhere. The bactericidal effect can be represented by a logarithmic killing curve and calculated as "equivalent air changes per hour." The resultant reduction of the contamination of air in a room depends on the pre-existing rate of removal of bacteria-carrying particles by ventilation and sedimentation. In order to halve the mean concentration of bacteria-carrying particles, it is necessary to double the overall rate of removal.

Four important factors affect the killing rate of α-hydroxy-carboxylic acids. (1) Increase in concentration of the bactericide usually gives an S-shaped curve with

little killing at low concentrations, then a rapid increase and finally a relatively constant maximum. (2) Relative humidity exerts a dominant effect giving maximum killing between 60% and 80%. A rapid fall in killing rate below 50% relative humidity considerably reduces the effectiveness under many working conditions. (3) Increase in particle size diminishes the killing rate. (4) The nature of the particles also affects the rate, which is low with dry dust particles, intermediate with natural sprayed salivary flora, and very high with sprayed cultures. Different species of organisms vary in sensitivity. In field trials most airborne organisms are dry, dust-borne and resistant.

Dr. M. Mitman had found that a germicidal mist of resorcinol generated in a cubicle by a simple apparatus, the aerovap, failed to give significant reduction in the numbers of organisms and hæmolytic streptococci falling on exposed plates. Nevertheless, he felt that intermittent aerial disinfection at the times of activities known to cause peak infection would be a valuable method of preventing spread of infection from cubicle to corridor.

Major A. C. Cunliffe described an experiment which was made during an outbreak of infection with *Strep. pyogenes,* types 4 and 12, in a ward of children undergoing plastic operations of the palate, in which oil-treatment of the bed-clothes was associated with a marked reduction in the numbers of airborne streptococci and a significant decrease in the cross-infection rate. In the six weeks before the application of oiled bed-clothes the average number of *Strep. pyogenes* isolated by a slit sampler during bed-making was 22·6 ± 8·1 per cu. ft. of air, while all 16 post-operative patients were found at routine swabbings to have acquired *Strep. pyogenes* (a cross-infection rate of 100%). In the following nineteen days when all bed-clothes were oil-treated, the average number of streptococci was 0·7 ± 0·24; 5 (41·7%) of 12 patients were cross-infected. In the next three weeks when unoiled bed-clothes were used the average number of streptococci rose to 2·7 ± 0·8 and 70·6% of 17 patients were cross-infected.

Dr. J. L. Burn showed photographs illustrating some points in the prevention of airborne infection in schools and day nurseries.

Dr. J. M. Alston did not agree that acute respiratory disease could be attributed entirely to airborne infection. Endogenous infection and contact spread were important, and contaminated hands and handkerchiefs probably played a large part. Impregnation of handkerchiefs with penicillin or other antibacterial substance seemed worth experiment.

Dr. William Gunn commented on Dr. Wright's results and conclusions stressing that significant differences between test and control groups could be expected only when atmospheric contamination was high. Under present conditions a certain amount of infection was to be expected especially in highly susceptible children. Oiling of floors and fabrics was the only practicable method available for suppressing dust.

Professor Ronald Hare said that in United States Army and Navy barracks ultraviolet light and triethylene glycol aerosols had failed to produce any dramatic reduction in upper respiratory tract infections. Prevention of a very infectious virus disease such as influenza might be much more difficult than prevention of a microbic infection such as scarlet fever. Wide variations of attack rates occurred in comparable groups of persons without control measures, and therefore prolonged investigations would be necessary before any particular prophylactic could be said to have achieved its object.